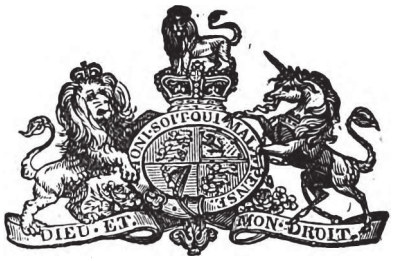

A.D. 1873, 12*th* JUNE. N° 2086.

Telegraphic Apparatus.

LETTERS PATENT to Sir William Thomson, Knight, of Glasgow College, Doctor of Laws and Professor of Natural Philosophy in the University and College of Glasgow, and Fleeming Jenkin, of No. 5, Fettes Row, Edinburgh, for the Invention of "IMPROVEMENTS IN TELEGRAPHIC APPARATUS."

Sealed the 2nd December 1873, and dated the 12th June 1873.

PROVISIONAL SPECIFICATION left by the said Sir William Thomson and Fleeming Jenkin at the Office of the Commissioners of Patents, with their Petition, on the 12th June 1873.

We, Sir WILLIAM THOMSON, Knight, of Glasgow College, Doctor of Laws and Professor of Natural Philosophy in the University and College of Glasgow, and FLEEMING JENKIN, of No. 5, Fettes Row, Edinburgh, do hereby declare the nature of the said Invention for "IMPROVEMENTS IN TELEGRAPHIC APPARATUS," to be as follows:—

Our improvements relate to the apparatus by which telegraphic signals are sent and received, the object of the Invention being to increase speed and to diminish the risk of error.

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Sir W. Thomson & Jenkin's Improvements in Telegraphic Apparatus.

We effect our object by constructing improved sending apparatus, by which we can with greater ease and certainty make the contacts required for many of the compensated signals described in our joint Patent, No. 2047, in the year 1860, and in the Patent No. 329, in the year 1858, taken out by one of us, and in the Patent No. 1784, in the year 1865, taken out by one of us in conjunction with Mr. Varley, and in Patents No. $\frac{206}{1860}$, and $\frac{3453}{1862}$, granted to the said Mr. Varley, and we introduce an improvement in the receiving apparatus described in the Patents taken out by one of us, No. 2147, in the year 1867, and No. 252, in the year 1871, by which it is simplified and rendered more suitable for use on land lines or short submarine lines where great sensibility is not required.

Our improvement in the receiving instrument now known as the siphon recorder consists in binding a small brush, such as is used for very fine water-colour painting, to the end of the siphon, which will then paint the signals on the paper, leaving a continuous trace without the spurting of fine drops by electricity. The same end is attained by grinding the end of the siphon smooth and parallel to the paper. The siphon thus prepared will indicate such currents as are sent on land lines of moderate length. This improvement renders unnecessary for these cases the mouse mill and electro-static arrangements hitherto used with the siphon recorder.

In order to send the signals we prepare the message in type or in punched paper. When punched paper is used we employ holes on the right and left hand sides for positive and negative signals in a well known manner, and in some forms we employ a row of central holes.

When type is used we employ similarly a row of right and left hand projections for positive and negative signals, and in some forms a central row of projections for spaces.

When we desire to send the curb key contacts or similar groups of contacts described in the Patent dated July 6th, 1865, No. 1784, we use the holes or projections to throw the line into connection with the mechanism used to make the dot contacts, dash contacts, and space contacts if these are used according to the hole punched or type set, and we do this in such a manner that the beginning and end of each group of contacts required for a signal does not depend on the perfect spacing of the holes or type; the hole or projection determines which contact or

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group of contacts shall be made, but the length and arrangement of each group of contacts depends only on the cam or other arrangement used to make the contacts; thus any required group of contacts may be sent by one and the same strip of paper and by the same machine. We effect this by causing the hole or projection to throw a portion of the machinery connected electrically with the line into mechanical gear with the particular cam or other mechanism required to be in action.

The commencement of the mechanical interlocking is not limited to one exact position of the cam, but will take place correctly though the types or holes be not very uniformly spaced. The electrical contacts determined by the cam or mechanical gearing begin at a perfectly definite point, which is exactly that at which the group of contacts determined by the cam or mechanical gearing previously in use end.

We employ a new mode of adjusting the lengths of the contacts made by cams, so that one projection on one cam may be made use of to give a succession of contacts of any length; this we effect by making the length of the contact pieces which rest on the cam adjustable so that if the projection wire $^1/_2$ inch long, and the contact piece resting on it $^3/_4$ inch long, the length of contact would be that given by a cam $1^1/_4$ inch long, and a sharp contact edge resting on it.

Instead of making the length of one contact piece adjustable we effect the same object by a succession of two or more contact pieces making the same contact, and one beginning its function before the previous one leaves off; the distance between these contact pieces can also be adjusted.

Where less perfect compensation is required than is given by the above arrangement we allow the projections of the type to make the contacts required by moving a succession of springs, and adjust the relative length of the groups of contacts by the mode above described, so that a single projection of the type will send a whole series of curb key contacts precisely as one projection on the cam will send the group of contacts.

When we employ type we prefer to use a wheel or endless band, and set it up by touching keys on the wheel or band when in motion; the message is obliterated by suitable rollers after the contacts have been made, and each part of the wheel or band comes round to the operator ready to have the message set up. In this plan there are no loose types, and a whole letter or more than one letter where these are simple can

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be set up by one motion of the hand or hands as a chord is played on the piano; this saves labour in keying and obviates all necessity for paper. Keys may be arranged so as to be worked in exactly the manner practiced with the present positive and negative keys, and so that each motion sets one type, but we prefer the simple direct action. The wheel may be driven by a treadle or otherwise.

When we employ punched paper, which is necessary where the speed required is so great that the above ring sender cannot be manipulated, we use an improvement in the puncher described in the Patent No. 252, in the year 1871, this improvement consists in a plan by which the fly wheel there described is rendered unnecessary, the crank being carried past the dead points by a spring which acts as an alternative accumulator and restorer of the work employed to turn the crank.

The final position of the roller drawing forward the paper is determined by a catch which secures the roller at the proper point of its revolution, the catch being lifted out of gear by a cam when the roller is required to be free.

SPECIFICATION in pursuance of the conditions of the Letters Patent, filed by the said Sir William Thomson and Fleeming Jenkin in the Great Seal Patent Office on the 12th December 1873.

TO ALL TO WHOM THESE PRESENTS SHALL COME, we, Sir WILLIAM THOMSON, Knight, of Glasgow College, Doctor of Laws and Professor of Natural Philosophy in the University and College of Glasgow, and FLEEMING JENKIN, of No. 5, Fettes Row, Edinburgh, send greeting.

WHEREAS Her most Excellent Majesty Queen Victoria, by Her Letters Patent, bearing date the Twelfth day of June, in the year of our Lord One thousand eight hundred and seventy-three, in the thirty-sixth year of Her reign, did, for Herself, Her heirs and successors, give and grant unto us, the said Sir William Thomson and Fleeming Jenkin, Her special license that we, the said Sir William Thomson and Fleeming Jenkin, our executors, administrators, and assigns, or such others as we, the said Sir William Thomson and Fleeming Jenkin, our executors, administrators, and assigns, should at any time agree with, and no

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others, from time to time and at all times thereafter during the term therein expressed, should and lawfully might make, use, exercise, and vend, within the United Kingdom of Great Britain and Ireland, the Channel Islands, and Isle of Man, an Invention for "IMPROVEMENTS IN TELEGRAPHIC APPARATUS," upon the condition (amongst others) that we, the said Sir William Thomson and Fleeming Jenkin, our executors or administrators, by an instrument in writing under our, or their hands and seals, or under the hand and seal of one of us or them, should particularly describe and ascertain the nature of the said Invention, and in what manner the same was to be performed, and cause the same to be filed in the Great Seal Patent Office within six calendar months next and immediately after the date of the said Letters Patent.

NOW KNOW YE, that we, the said Sir William Thomson, and Fleeming Jenkin, do hereby declare the nature of the said Invention, and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement thereof, that is to say :—

Our improvements relate to the apparatus by which telegraphic signals are sent and received, the object of the Invention being to increase speed and to diminish the risk of error.

We effect our object by constructing improved sending apparatus by which we can with greater ease and certainty make the contacts required for many of the compensated signals described in our joint Patent, No. 2047, in the year 1860; and in the Patent No. 329, in the year 1858, taken out by one of us; and in the Patent No. 1784, in the year 1865, taken out by one of us in conjunction with Mr. Varley; and in Patents No. $\frac{206}{1860}$ and $\frac{3453}{1862}$, granted to the said Mr. Varley; and we introduce an improvement in the receiving apparatus described in the Patents taken out by one of us, No. 2147, in the year 1867, and No. 252 in the year 1871, by which it is simplified and rendered more suitable for use on land lines or short submarine lines where great sensibility is not required.

Our improvement in the receiving instrument now known as the siphon recorder consists in binding a small brush such as is used for very fine water colour painting to the end of the siphon, which will then paint the signals on the paper, leaving a continuous trace without the spurting of fine drops by electricity. The same end is attained by

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grinding the end of the siphon smooth and parallel to the paper. The siphon thus prepared will indicate such currents as are sent on land lines of moderate length. This improvement renders unnecessary for these cases the mouse mill and electro-static arrangements hitherto used with the siphon recorder.

In order to send the signals we prepare the message in type or in punched paper. When punched paper is used we employ holes in the right and left hand sides for positive and negative signals in a well known manner, and in some forms we employ a row of central holes.

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The commencement of the mechanical interlocking is not limited to one exact position of the cam, but will take place correctly though the types or holes be not very uniformly spaced. The electrical contacts determined by the cam or mechanical gearing begin at a perfectly definite point, which is exactly that at which the group of contacts determined by the cam or mechanical gearing previously in use end.

We employ a new mode of adjusting the lengths of the contacts made by cams so that one projection on one cam may be made use of to give

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a succession of contacts of any length. This we effect by making the length of the contact pieces which rest on the cam adjustable, so that if the projection were $^1/_2$ inch long and the contact piece resting on it $^3/_4$ inch long the length of contact would be that given by a cam $1^1/_4$ inch long, and a sharp contact edge resting on it.

Instead of making the length of one contact piece adjustable we effect the same object by a succession of two or more contact pieces making the same contact, and one beginning its function before the previous one leaves off. The distance between these contact pieces can also be adjusted.

Where less perfect compensation is required then is given by the above arrangement we allow the projections of the type to make the contacts required by moving a succession of springs, and adjust the relative length of the groups of contacts by the mode above described, so that a single projection of the type will send a whole series of curb key contacts precisely as one projection on the cam will send the group of contacts.

When we employ type we prefer to use a wheel or endless band, and set it up by touching keys on the wheel or band when in motion. The message is obliterated by suitable rollers after the contacts have been made, and each part of the wheel or band comes round to the operator ready to have the message set up. In this plan there are no loose types, and a whole letter or more than one letter where these are simple can be set up by one motion of the hand or hands as a chord is played on the piano. This saves labor in keying, and obviates all necessity for paper. Keys may be arranged so as to be worked in exactly the manner practised with the present positive and negative keys, and so that each motion sets one type, but we prefer the simple direct action. The wheel may be driven by a treadle or otherwise.

When we employ punched paper, which is necessary where the speed required is so great that the above ring sender cannot be manipulated, we use an improvement in the puncher described in the Patent No. 252, in the year 1871. This improvement consists in a plan by which the fly wheel there described is rendered unnecessary, the crank being carried past the dead points by a spring which acts as an alternative accumulator and restorer of the work employed to turn the crank.

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The final position of the roller drawing forward the paper is determined by a catch which secures the roller at the proper point of its revolution, the catch being lifted out of gear by a cam when the roller is required to be free.

Our improvement in the recorder requires no further description than that given above.

We will first describe more fully one portion of our Invention which we call the ring sender, consisting of the wheel or endless band above mentioned, in which type is set up by touching keys on the wheel when in motion.

Figures 1 and 2, Sheet 1, shew the front and side elevation of one form of the ring sender. The wheel or ring A, A, is driven by a treadle B through spur wheel gearing at C and D and E, the ring may be driven at a uniform speed of about $2^1/_4$ revolutions per minute to send 20 words per minute. On the periphery of the ring A are arranged about 130 uniformly spaced and similar type keys "*a*, *a*, *a*, etc;" each key can slide in V grooves, Figure 3, Sheet II. in a direction parallel to the axis of the wheel A. Each key has a projection at the centre of its length which serves to make the necessary contacts in one of the ways to be hereafter described. Each key has a little head at each end which may be made of vulcanite, and by which it can be pressed backwards or forwards by the hand while being set. When the projection of *a* is opposite the centre of the groove H in the periphery of A, no signal is produced at the further end of the line. When the projection of *a* is at the right extreme of its range a dot or positive signal is sent into the line, and when at the left extreme of its range a negative signal is sent which for brevity we may call a dash, although it is of equal length with the dot, the projection in fact plays a part analogous to the well-known holes punched in a strip of paper by which spaces, dots, and dashes are produced, the central row of holes giving spaces, the holes on the one side positive dots, and the holes on the other side negative dots, which we call dashes.

The type is set up by the operator with both hands, one on each side of the ring A. As the periphery of the wheel comes up to him he finds all the keys in their central position, having been brought into this position by passing the rollers R and R^1, then to send the letter *a* with one finger of the left hand he presses back a type and simultaneously

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with one finger of the right hand he presses back the following type in the opposite direction. If the letter *a* is to be followed by the letter S he lets one type pass unmoved and then presses the three following types back with his left hand. In this way one or more letters can be set up at once by a simultaneous motion of the two hands as a cord or cords are played on the piano; the advantage of the instrument consists in the accurate spacing which it gives, together with simple methods of producing the groups of contacts required for perfect signals through long submarine lines. These contacts may be produced in three distinct ways,—

Firstly, we use each type to produce a series or group of contacts by allowing the projection of the type to make electrical contact successively with a series of adjustable springs ranged with the contact pieces one after the other, as shewn in Figure 7, where three adjustable springs *b*, *c*, *d*, having adjustable contact pieces b^1, c^1, d^1, are ranged so as successively to make contact with the projection of *a*. *b* and *d* may be connected with the positive pole of a battery, and *c* with the negative pole of an equal battery; the other poles being to earth; then if the projection *a* is in connection with the line and otherwise insulated, the three springs as the type passes under them, will send the group of three contacts required for the curb key described in the Patent No. 1784, A.D. 1865, granted to Messrs. Thomson and Varley, the length of the contacts made by *b*, *c*, and *d*, can be adjusted by adjusting the distance between the pairs of conical nuts at b^1, c^1, and d^1; the springs which can be secured in their places by pinching nuts *b*, *c*, and *d*, must be so adjusted longitudinally that the first contact made by b^1 coincides with the last made by d^1, as a succession of keys pass under the contact pieces, and moreover the last contact of b^1 must coincide with the first of c^1, and the last of c^1 with the first of d^1; it is clear that the same plan might be adopted either to send single contacts or series of four or five, or more contacts with the same or different batteries for each signal. Adjustable pairs of springs opposite one another, and electrically connected may be used instead of the adjustable contact pieces or conical nuts. The ring sender may be used without our plan of giving varying lengths of contacts by a single projection, or this plan of making groups of carefully adjusted contacts by a single projection may be applied to any cam.

Our second plan of making contacts by the projections in the ring

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sender differs from the first only in avoiding rubbing contacts, and is shewn in detail in Figures 3, 4, 5, and 6, Sheets I. & II. The springs *b* and *c*, with their adjustable contact pieces *b* and *c*, make the two contacts for the dash. The spring *e* makes the earth contact for spaces, and the springs *f* and *g* make the two contacts for a dot, the series of five springs being adapted to make the contacts described in the Patent No. 2047 granted to us in 1860, and more particularly indicated in Figure 10, Sheet 1 of that Patent. The contact is made not between the projection *a* and the contact spring, but between a second pair of springs, as at b_2, b_3, or c_2, c_3, Figure 3, insulated in the usual way. The terminals of these are shewn at *t*, *t*, one being connected to the battery, and the other to the line. The longitudinal positions of each group of springs can be adjusted by the screws *i* which move the whole system in small V grooves *v*, Figure 5. The lengths of each contact can be adjusted by the conical nuts as before.

When the contacts are properly adjusted, the beginning of the contacts made by *b*, *e*, and *f* must coincide, that is to say, if the projection *a* were prolonged so as to work all three instead of one all three contacts would begin together. Similarly the end of the contacts made by *c*, *e*, *g*, must coincide, and the end of these contacts must coincide with the beginning of the contacts made by *b*, *e*, and *f*, due to the next key; moreover, the contact pieces of *b* and *c* must be so adjusted that the contact made by *b* is a little longer than that made by *c*, and that the contact made by *c* begins exactly where that made by *b* ends. Again, the contact pieces of *f* and *g* must be so adjusted that the contact made by *f* is a little longer than that made by *g*, and that the contact made by *g* begins exactly where that made by *f* ends. When this has been done *b* and *c* will send dashes, *f* and *g* will send dots, and *e* will send spaces, the motion of the type being in the direction shewn by the arrows. It is easy to adjust the relative lengths of the contacts made by *b* and *c*, or *f* and *g*, so as to suit any particular line.

The groups of contact springs are all attached to a bracket F, which can be detached by unscrewing the single nut G for the purpose of examining or adjusting the contacts. The bracket when replaced occupies a position perfectly determined by three pins *f*, *f*, *f*, resting in a hole and a slot; and on a plane, respectively, two brackets F and F^1, Figure 1, are provided, so as to give a spare set of contacts which may be differently adjusted.

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Our third method of making contacts by the ring sender is to allow the projections to throw a portion of the machinery electrically connected with the line into mechanical gear with a cam used to send the group of contacts required; but this mode of making the contacts is preferred by us to be used in connection with punched paper, and will be described in connection with our automatic paper sender.

It will be obvious that projections in the keys, or holes in the metal keys, might be made to play exactly the same part as the holes in a strip of paper. It is also clear that a slot in the key might be made to give contacts instead of a projection, as shewn in the above described Drawing.

Figure 6 shews a good method of constructing the movable key or type. *a* is the projection carried by the circular pin P, which slides in V grooves V, V^1, being held into them by the spring S attached to a projection Q, which works in a slot cut in the wheel A. The finger pieces or heads U may be made of vulcanite if *a* is required to be insulated. In this case the arms of the wheel A are attached to a vulcanite boss.

When we employ punched paper to transmit messages instead of the ring sender, we use the transmitting apparatus, one form of which is shewn in Figures 1 to 8, Sheet III., adapted for a central row of holes.

Figure 1 is a side elevation; Figure 2, a front elevation; Figure 4, a plan; Figure 3, a partial plan; Figure 5, a partial plan; Figure 6, a sectional side elevation; Figure 7, a diagram; and Figure 8, a partial perspective sketch.

The paper prepared with holes on the one side of the central line corresponding to the dots required, and on the other with holes corresponding to the dashes is passed between the drums H and I in the direction shewn by the arrow, Figure 1.

The shafts N and O are so connected by gearing that the axis O makes one revolution for each hole in the central row of the paper, or for each dash and dot when these are consecutive. The projections *h* enter this central row of holes and gearing with the apertures *i*, *i*, *i*, of the drum I, drawing the paper forward at an uniform rate, the clockwork is driven

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by a spring or weight, and the speed is controlled by a suitable governor. There are two similar levers b, a, and b^1, a^1, on the two sides of the wheel A, A^1, which is fast on the shaft O. The two halves of the wheel A, A^1, are insulated. These levers are hinged on the axis g, they are insulated from one another, and the ends b, b^1, are insulated from the axis g. Two similar insulated cams G, G^1, on opposite sides of A, A^1, allow the ends b, b^1, to rise at one portion of the revolution of the wheel A. Only one cam G is shewn in the Drawings, the second being precisely similar to it. The ends b, b^1, of the levers tend to rise in consequence of the constant pressure of the springs m, m^1, Figure 4. When a hole passes under the end a of the lever, the end b is free to rise, but when solid paper passes under a the end b does not rise, the gearing between the axes N and O is such that the passage of the punched holes under a corresponds to the passage of the recess in the cams G past the end b. Thus when a hole passes the end a, corresponding to a dash, the end b tends to rise, whilst the solid paper under b^1 prevents b_1 from rising. Similarly, when a hole passes the end a^1 corresponding to a dot the end b_1 tends to rise, while the solid paper prevents b from rising. Two openings f and f_1 are made in the periphery of the wheel A, A^1, and when the ends b or b_1 tend to rise they tend to lift the ends of the two springs E_2 and L_2 through f or f_1. The passage of a dash hole under a thus causes E_2 to be lifted through f, whilst L_2 remains depressed. On the contrary the passage of a dot hole under a_1 causes L_2 to be lifted through f_1, leaving E_2 depressed. When either L_2 or E_2 have been lifted they are caught by the projecting rim of A or A_1, and kept up during a whole revolution of the shaft O. The ends b or b^1 are however depressed by the cams G or G^1, immediately after L^2 or E^2 have been caught by the rim, and a or a^1 are thus lifted out of the hole in the paper, so as not to impede the progress of the paper. If a succession of dot holes occur the spring L^2 remains up and E^2 down. If a succession of dash holes occur the spring L^2 remains down and E^2 up, when a dash is followed by a dot the instant at which the spring E^2 falls, and that at which L^2 rises to its full height depends not on the exact position of the hole in the paper but on the passage of the apertures f, f_1, and the changes in the position of the springs can consequently only occur at perfectly uniform intervals, when the shaft O revolves uniformly.

The spring E^2 is in connection with the earth through the terminal E; the spring L^2 is in connection with the line through the terminal L.

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When either L^2 or E^2 are up they are in connection with an insulated bar or junction piece B, B^1, B^2, B^3, B^4, B^5; when they are down they are in connection with an insulated bar or junction piece F, F^3. The two cams K, K^1, each insulated serve to make connections between the poles of two batteries and the bars B and K. At the instant when E^2 rises and L^2 drops the cam K lets up the end of the spring C^2 in connection with the copper pole of a battery, while the cam K^1 presses down the spring Z^2 in connection with the zinc pole, the same battery thus putting copper to earth through the terminal E, and zinc to the line through B and L^2. After rather more than half a revolution the cams K and K^1 put the line to copper and earth to zinc, and this action will continue so long as dash holes continue to pass under *a*. When however a dot hole passes under *a* the positions of L^2 and E^2 are reversed; then the cam K puts first copper to line for a longer period, and then to earth for a shorter period; while K^1 puts zinc first to earth for a longer period and then to the line for a shorter period. If no hole passes under either *a* or a^1 both *b* and b^1 remain depressed, and L^2 and E^2 remain in contact with F^3, thus the line remains to earth, and the cams K and K^1 put each pole of the battery alternately to earth, producing no effect on the line.

The series of changes is most easily followed by means of the Diagram, Figure 7. The cams K and K^1, as described and shewn are suitable to send the signals already described in connection with the ring sender, and particularly illustrated by Figure 10, Sheet 1, of the Patent No. 2047, A.D. 1860; but the cams may be arranged to send any groups of contacts, it being clear that the reversal of the position of the springs L^2 and E^2 will reverse the sign of the signal sent by the cams, and that the length of each signal is measured by one revolution of the cams. The lengths of the contacts made by the cams or by projections on the cams may be adjusted by the same means as that which has already been described in connection with the type of the ring sender.

The several bars and springs C, Z, L, B, and F are insulated from one another by being attached to a vulcanite slab M.

We punch the paper employed in the paper automatic transmitter by means of the puncher shewn in Figures 9, 10, and 11, Sheet IV., representing an improved form of the puncher described in the Patent No. 252, A.D. 1871, granted to one of us.

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Figure 9 is a side elevation; Figure 10, a plan; and Figure 11, an end elevation. Three keys A, B, C, punch the holes by pressing on three dies *a*, *b*, *c*. What in the former Patent was termed the revolver shaft is shewn at R; this shaft is turned by a connecting rod D and crank E, worked by a lever which rocks when any of the three levers A, B, or C are depressed.

The revolution of the revolver shaft past the dead points is produced by the spring G, which alternately stores up the work done by the operator and restores it to the mechanism by turning the shaft R. A snail K works with the spring H to force it back, and the spring G is forced back by the cams F, F; we place these cams on the shaft instead of the connecting rod. The spring H has a V at the end, which acts as a clutch, determining by its interlocking with the wheel W the exact point at which paper roller T on the axis S shall stop. The revolver shaft during a portion of its revolution drives the paper roller by the same means as has been described in the above named Patent, No. 252, 1871, so that the paper stops and starts gradually.

In connection with the puncher we claim only the improved arrangement of the parts as shewn in the Drawing, which makes the instrument more efficient.

We claim, the addition of the brush to the recorder and the apparatus described as the ring sender and automatic paper transmitter, substantially as described.

In witness whereof, we, the said Sir William Thomson and Fleeming Jenkin, have hereunto set hands and seals, this Ninth day of December, in the year of our Lord One thousand eight hundred and seventy-three.

WILLIAM THOMSON. (L.S.)
FLEEMING JENKIN. (L.S.)

LONDON:
Printed by GEORGE EDWARD EYRE and WILLIAM SPOTTISWOODE,
Printers to the Queen's most Excellent Majesty. 1873.

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A.D. 1873. JUNE 12. N°2086.
THOMSON & JENKIN'S SPECIFICATION.

(4 SHEETS)
SHEET 1

FIG. 7.

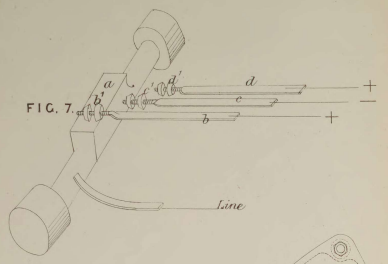


FIG. 1.

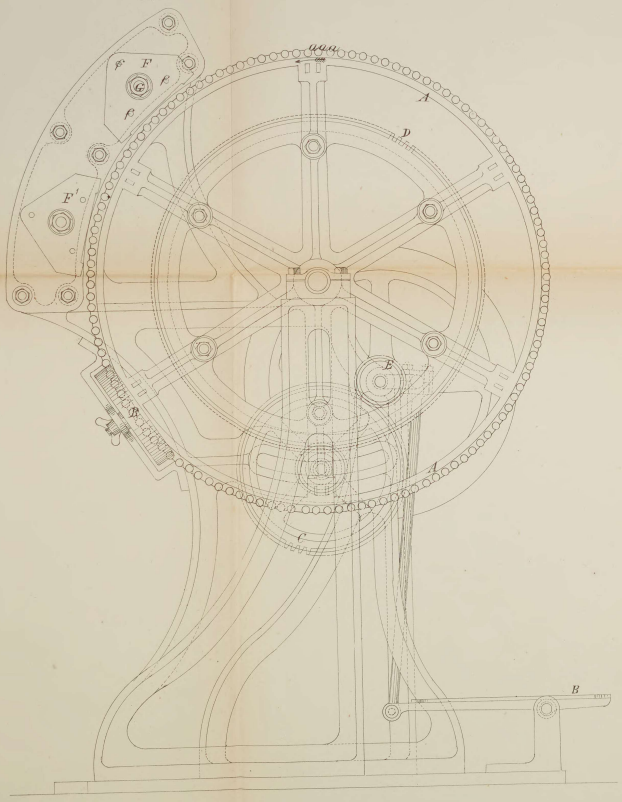
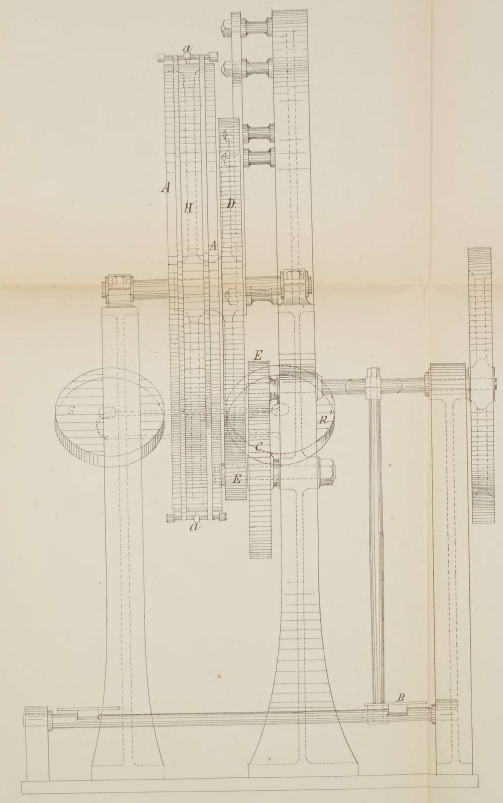


FIG. 2.



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THOMSON & JENKIN'S SPECIFICATION.

(4 SHEETS)
SHEET 2

FIG. 3.

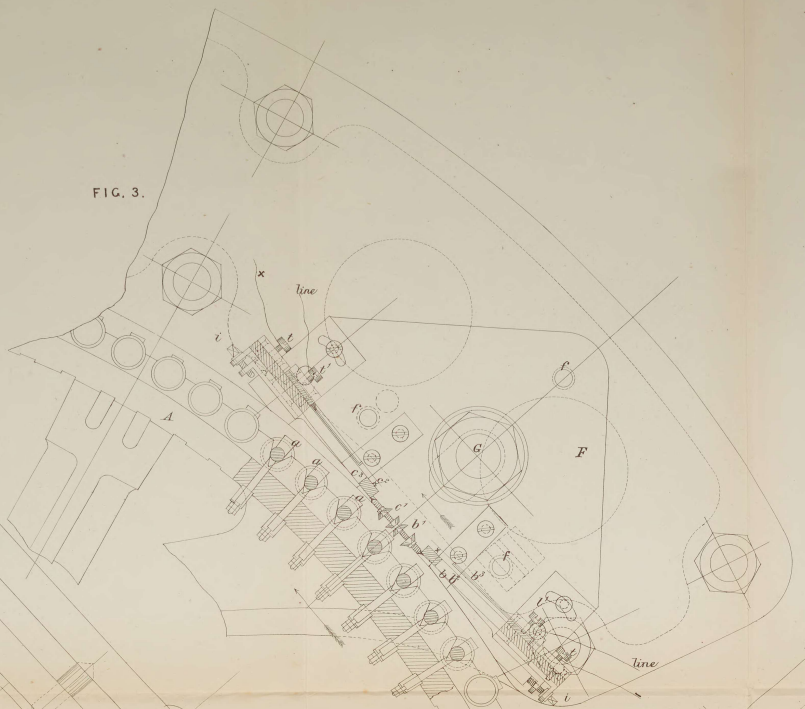

FIG. 6.

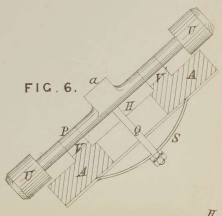

FIG. 4

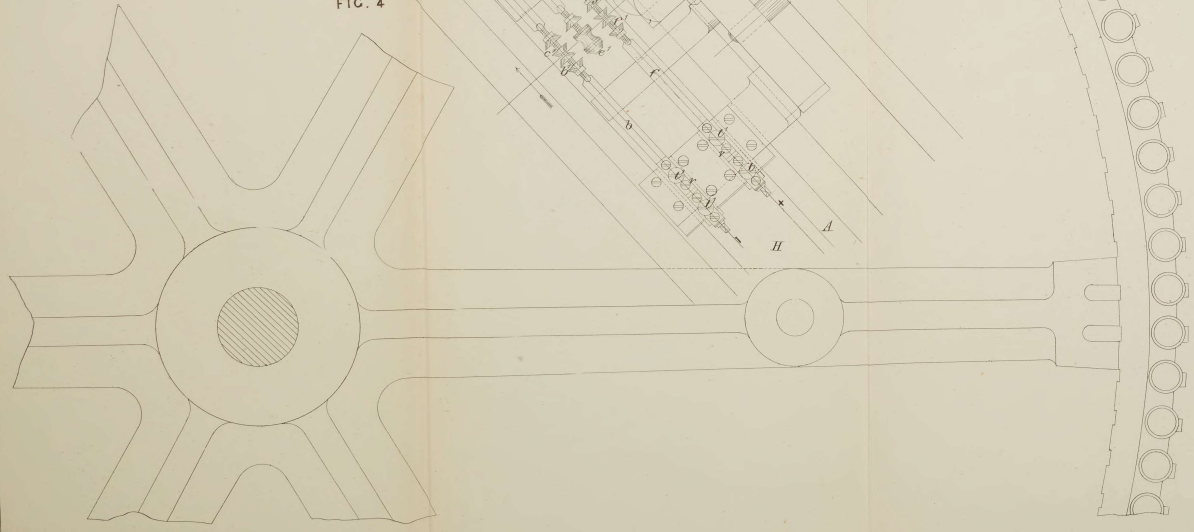

FIG. 5.

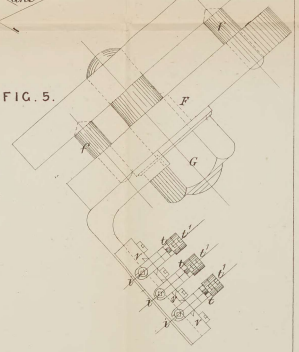

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FIG. 8.

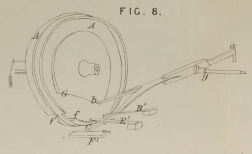

FIG. 1.

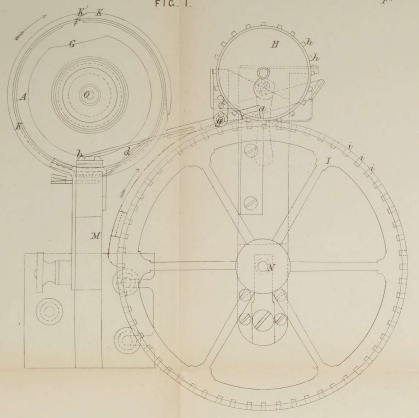

FIG. 2.

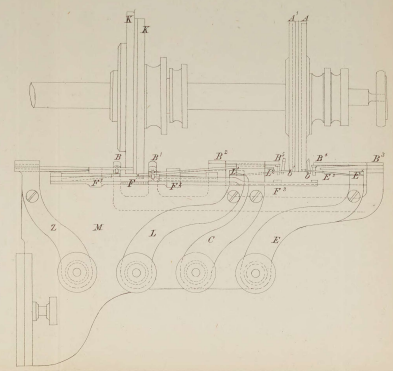

FIG. 6.

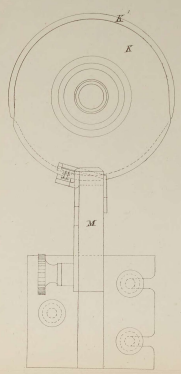

FIG. 3.

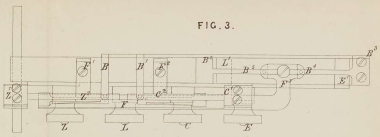

FIG. 4.

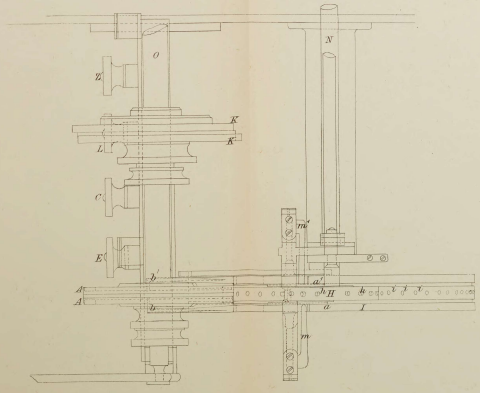

FIG. 5.

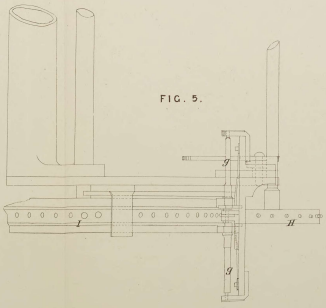

FIG. 7.

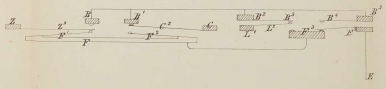

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FIG. 9.

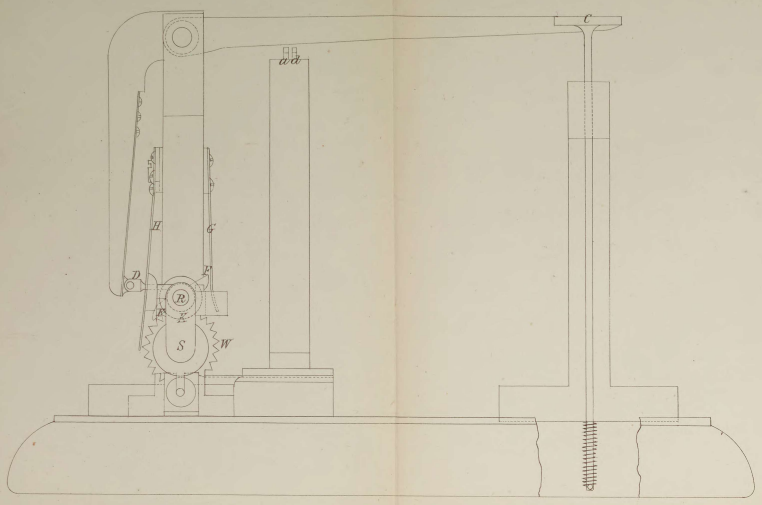


FIG. 10

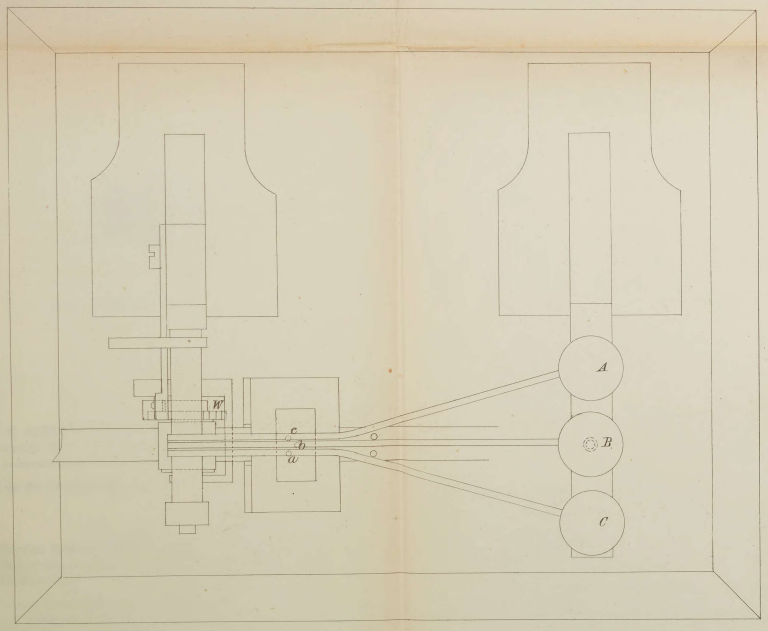
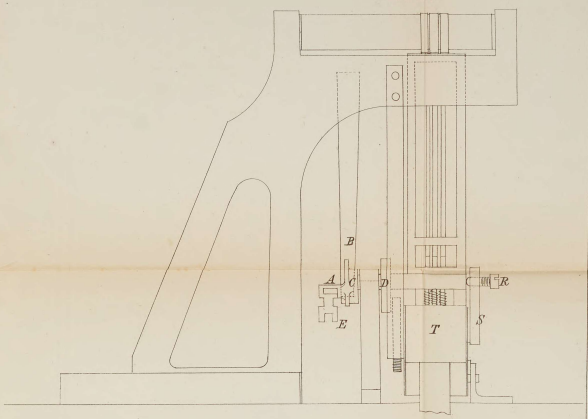


FIG. 11.



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